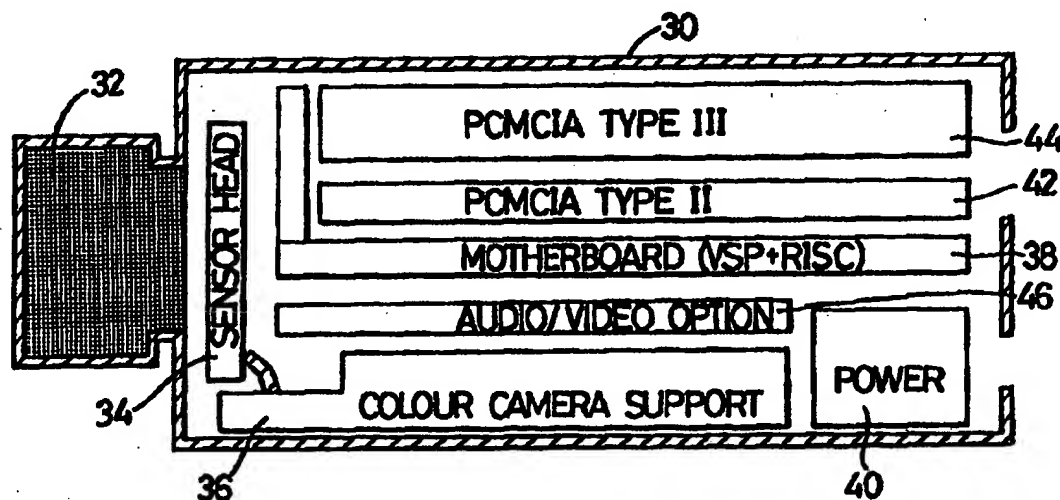




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(54) Title: DIGITALLY NETWORKED VIDEO CAMERA



PHYSICAL CONFIGURATION.

(57) Abstract

A self-contained, digitally networked video camera comprises a housing (30) enclosing a camera module having video image sensor means (36) adapted to generate a video signal, signal processing means (38), including a video signal processor (VSP) which receives a digital video signal from the camera module and a multi-tasking RISC processor, adapted to compress and/or analyse said video signal and to output a digital data signal, and digital interface input/output means (42, 44), such as PCMCIA cards adapted to transmit said digital data signal to an external, digital communications network in accordance with a predetermined communications protocol, such as TCP/IP. The camera may be connected directly to a digital communications network, such as a LAN or WAN, for the transmission of compressed, digital video signals and/or associated data directly to host PC's connected to the network. Audio signals may also be processed.

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DIGITALLY NETWORKED VIDEO CAMERA

1

2

3 This invention relates to improvements in video camera
4 apparatus. More particularly, the invention relates to
5 video cameras adapted for direct connection to digital
6 communications networks, and to video cameras which can
7 analyse what they see and/or hear and which can
8 interface directly to digital networks.

9

10 In this field it is already known that:

11

12 1 Cameras can be interfaced to digital networks via
13 PC's or separate dedicated control units (see, for
14 example, GB-A-2231753; US-A-5237408; WO-A-
15 90/09717).

16

17 2 Videophones can interface directly to some digital
18 networks (WAN - Wide Area Networks) but are unable
19 to perform image analysis or audio analysis for
20 the purpose of detecting specific events and
21 moreover cannot interface directly to Local Area
22 Networks (LAN).

23

24 3 Analysis of images has been carried out within a
25 camera unit (such systems are available from, for
26 example, VLSI Vision Limited of Edinburgh, UK;
27 Intelligent Camera, Image Inspection Limited of
28 Epsom, UK; and MAPP/LAP, IVP, Linkoping, Sweden)

1 but never in conjunction with the ability to
2 interface directly to digital networks.

3

4 Known cameras and systems of these types have the
5 disadvantages that:

6

7 1 It is often impractical and not cost effective to
8 use a PC or separate control unit to allow a
9 camera to interface to LAN/WAN. This is
10 especially true in circumstances where a PC would
11 not usually be present such as in remote
12 surveillance applications: eg construction site
13 monitoring.

14

15 2 Existing surveillance cameras, by transmitting
16 video in analogue form, are severely restricted
17 in quality of transmission and recording,
18 automation of surveillance operations,
19 restrictions on network topologies, ability to
20 cross-reference to other events whose occurrence
21 is reported digitally.

22

23 3 Existing cameras which can perform image analysis
24 cannot transmit images and the results of analysis
25 over digital networks, thus severely restricting
26 interpretation of results and integration of
27 cameras with existing digital systems.

28

29 Use of digital cameras is almost exclusively oriented
30 around PC's and workstations. The requirement for a
31 host PC for capturing and transmitting video is
32 circumvented by this invention. This is achieved by
33 the integration of the hardware and software previously
34 provided by the combination of a camera and separate
35 computer (PC) into a single, stand-alone surveillance
36 camera unit.

1 The benefits of this are (a) the cost reduction through
2 not requiring a PC to be present and (b) the
3 flexibility achieved by enabling image input to digital
4 networks from locations where PC's cannot be used.

5
6 This, combined with the ability to automatically
7 analyse the acquired video and/or audio, within the
8 camera and in real time, allows the automation of a
9 wide range of visual/audio tasks via remote control
10 over digital networks.

11
12 In accordance with the present invention there is
13 provided a video camera comprising a housing enclosing
14 video image sensor means adapted to generate a video
15 signal, signal processing means adapted to process said
16 video signal and to output a digital data signal, and
17 digital interface input/output means adapted to
18 transmit said digital data signal to an external,
19 digital communications network in accordance with a
20 predetermined communications protocol.

21
22 Preferably, said signal processing means includes a
23 video signal processor (VSP) adapted to perform real-
24 time image compression and/or image analysis on said
25 video signal.

26
27 Preferably also, said signal processing means further
28 includes microprocessor means adapted to supervise
29 operation of said VSP and data input/output via said
30 interface means.

31
32 Most preferably, said microprocessor means comprises a
33 multi-tasking RISC processor.

34
35 Preferably also, said VSP has first memory means
36 associated therewith. Suitably, said first memory means

1 comprises dynamic random access memory.

2

3 Preferably also, said microprocessor means has second
4 memory means associated therewith. Suitably, said
5 second memory means comprises static random access
6 memory.

7

8 Preferably also, said communications protocol is
9 TCP/IP.

10

11 Preferably also, said interface means comprises at
12 least one PCMCIA card.

13

14 Preferably also, the camera further includes audio
15 sensor means, said signal processing means being
16 further adapted to process audio signals generated by
17 said audio sensor means.

18

19 While further modifications and improvements may be
20 made without departing from the scope of this
21 invention, the following is a description of one or
22 more examples of the invention, with reference to the
23 accompanying drawings in which:

24

25 Fig. 1 is a schematic illustration of a video
26 camera in accordance with the invention
27 connected to a digital network such as a LAN
28 or WAN;

29

30 Fig. 2 is a schematic block diagram
31 illustrating the hardware architecture of the
32 camera of Fig. 1;

33

34 Fig. 3 is a schematic illustration of the one
35 example of the physical configuration of the
36 camera of Fig. 1; and

1 Fig. 4 is a schematic block diagram
2 illustrating the software architecture of the
3 camera of Fig. 1.

4
5 The invention relates to a camera which can interface
6 directly to digital networks (such as Local Area
7 Networks (LAN's) or Wide Area Networks (WAN's)) and
8 which can carry out real time image compression and
9 analysis. Via the LAN/WAN it can communicate to one or
10 more PC control stations where the compressed video can
11 be decompressed and displayed and the results of the
12 image analysis viewed and/or recorded in a database.

13
14 Fig. 1 illustrates an example of such an arrangement,
15 in which one or more cameras 10 are connected directly
16 to the network 12, to which there are also connected
17 one or more host PC's 14. The camera 10 digitises,
18 compresses and analyses video images of a subject 16,
19 and the images and/or associated analysis results are
20 transmitted via the network 12 for display and/or
21 recordal on the host PC 14.

22
23 The hardware architecture of the camera 10 is
24 illustrated in block-diagram form in Fig. 2. As seen
25 in Fig. 2, the digitally-networked camera combines a
26 colour camera 18, including an image sensor and,
27 optionally, audio microphone, with a high performance
28 Video Signal Processor (VSP) 20 and a RISC processor
29 22. The output video/audio signals from the camera 18
30 are input to the VSP 20, which is connected to the
31 RISC processor 22. The processor 22 is in turn
32 connected to network interface hardware 24. Both the
33 VSP 20 and RISC processor 22 have memory means
34 associated therewith. In this example, dynamic random
35 access memory (DRAM) 26 is connected to the VSP 20 and
36 static random access memory (SRAM) and programmable

1 read only memory (PROM, preferably Flash EPROM) 28 is
2 connected to the RISC processor 22.

3
4 The colour camera 18 may be of the type including an
5 image sensor which directly outputs a digital video
6 signal, or may have an analogue sensor output with
7 separate analogue to digital conversion, or analogue to
8 digital conversion means may be incorporated between an
9 analogue camera and the VSP 20. In any case, the input
10 to the VSP 20 is a digital video signal. The same
11 applies to audio signals from the camera 18, if
12 applicable.

13
14 The VSP 20 supports real time image compression and
15 also acts as a highly parallel ALU for real time image
16 analysis. The RISC processor 22 supports a
17 multitasking operating system with built-in networking
18 and communications support, and also supervises the VSP
19 20. External input/output (i/o) is via the network
20 interface hardware 24; suitably, for example, via two
21 PCMCIA slots, allowing easy interfacing to LAN, WAN,
22 ISDN, wireless communications and mass storage devices.
23 It will be appreciated that digital network interfaces
24 may be provided by means other than PCMCIA-type
25 devices.

26
27 The camera also includes a proprietary digital gate
28 array (not shown), which implements bus bridges between
29 the major functional units of the architecture and
30 contributes to the high integration and low cost of the
31 camera unit.

32
33 This entire functionality is integrated within a single
34 camera unit. Fig. 3 shows an example of the physical
35 configuration of such a unit. In Fig. 3, a housing 30
36 supports the camera optics 32 and encloses the image

1 sensor 34 and associated electronics 36 of the camera
2 18; a motherboard 38 mounting the VSP 20, RISC
3 processor 22, DRAM 26, SRAM 28 and other associated
4 electronic components; a power supply unit 40; network
5 interface hardware such as type II and type III PCMCIA
6 cards 42, 44; and, possibly, additional, optional
7 audio/video hardware 46. It will be understood that
8 the illustrated physical configuration is given by way
9 of example only and may be varied while still
10 maintaining the essential functionality of the
11 invention.

12
13 The RISC processor 22 supervises the execution of image
14 processing and/or compression functions performed by
15 the VSP 20. The RISC processor 22 also supports a
16 real-time operating system (RTOS). The software
17 architecture of the camera is illustrated
18 schematically in Fig 4. This allows genuine
19 multitasking, which is essential in the environment.
20 In parallel, the RISC processor 22 supervises video
21 capture, compression, image processing, audio capture
22 and analysis, and PCMCIA i/o. Context switches must be
23 accomplished within a guaranteed time for this to be
24 effective. Normal multitasking facilities are
25 provided, such as message passing, mailboxes,
26 preemptive/round-robin/time-slice scheduling, interrupt
27 handling, etc.

28
29 Various communication protocol stacks may be supported
30 by the RTOS. Preferably, TCP/IP is implemented as the
31 high level network communications protocol. This
32 allows each camera to be assigned a unique internet
33 address and simplifies communications between cameras,
34 and between cameras and host PC's, across multiple
35 heterogeneous networks.
36

1 The advantages of the invention and/or the ways in
2 which the disadvantages of previously known
3 arrangements are overcome, include the following.

4

5 1. General

6

7 The Digitally-networked Camera is designed for real
8 time video capture, compression, analysis and
9 transmission in circumstances where it is either
10 impractical or not cost effective to use a host PC.
11 Since the camera operates stand-alone it can be plugged
12 directly into computer networks or deployed remotely in
13 the field using wireless communications.

14

15 2. Security & Surveillance

16

17 The digitally-networked camera contains the total
18 functionality required for analogue-networked
19 surveillance systems to migrate to digitally-networked
20 systems. Real-time video/audio compression allows
21 continuous transmission over existing LAN's without
22 significant degradation in LAN performance.

23

24 Since the Digitally-networked Camera performs real time
25 image processing, specific events can be detected and
26 reported to personnel. This will dramatically raise
27 the effectiveness of surveillance. The audio option
28 can be used to assist in detection of certain security
29 events including shrieks, breaking of glass, etc.

30

31 Thus, the invention allows semi-automation of security
32 surveillance systems. This has the potential to
33 significantly improve the cost-effectiveness of such
34 systems.

35

36 3. Traffic monitoring

1 The Digitally-networked Camera can be programmed to
2 analyse traffic speeds, congestion, vehicle
3 numberplates, etc and can directly report these
4 statistics and/or compressed video to a control centre
5 via a WAN, eg an ISDN/phone line.

6

7 4. Video-Conferencing

8

9 The Digitally-networked Camera can participate in PC-
10 based video conferences, transmitting compressed video
11 from locations where PC's cannot be used, such as
12 construction sites (wireless LAN) and factory shop
13 floors.

14

15 5. Industrial Inspection & Process Control

16

17 The invention allows automation of industrial
18 inspection, integrated with existing LAN's for
19 communication of inspection results to controller PC's
20 and control of cameras from PC's.

21

22 6. Miscellaneous

23

24 The wide range of PCMCIA cards available allows a
25 diverse range of applications to be addressed. For
26 example, to match images captured remotely with the
27 location at which they were captured it is possible to
28 use a GPS receiver card to let the camera get a fix on
29 the position of capture. This might be combined with a
30 cellular comms card to transmit the picture+location
31 immediately back to base.

32

33 Improvements and modifications may be incorporated
34 without departing from the scope of the invention as
35 defined in the Claims appended hereto.

36

1 Claims

2

3 1. A video camera comprising a housing enclosing
4 video image sensor means adapted to generate a video
5 signal, signal processing means adapted to process said
6 video signal and to output a digital data signal, and
7 digital interface input/output means adapted to
8 transmit said digital data signal to an external,
9 digital communications network in accordance with a
10 predetermined communications protocol.

11

12 2. A video camera as claimed in Claim 1, wherein
13 said signal processing means includes a video signal
14 processor (VSP) adapted to perform real-time image
15 compression and/or image analysis on said video signal.

16

17 3. A video camera as claimed in Claim 2, wherein
18 said signal processing means further includes
19 microprocessor means adapted to supervise operation of
20 said VSP and data input/output via said interface
21 means.

22

23 4. A video camera as claimed in Claim 3, wherein said
24 microprocessor means comprises a multi-tasking RISC
25 processor.

26

27 5. A video camera as claimed in Claim 2, wherein said
28 VSP has first memory means associated therewith.

29

30 6. A video camera as claimed in Claim 5, wherein said
31 first memory means comprises dynamic random access
32 memory.

33

34 7. A video camera as claimed in Claim 3, wherein said
35 microprocessor means has second memory means associated
36 therewith.

1 8. A video camera as claimed in Claim 7, wherein said
2 second memory means comprises static random access
3 memory and programmable read only memory.
4

5 9. A video camera as claimed in Claim 1, wherein
6 said communications protocol is TCP/IP.
7

8 10. A video camera as claimed in Claim 1, wherein said
9 interface means comprises at least one PCMCIA card.
10

11 11. A video camera as claimed in Claim 1, further
12 including audio sensor means, wherein said signal
13 processing means is further adapted to process audio
14 signals generated by said audio sensor means.
15

1/2

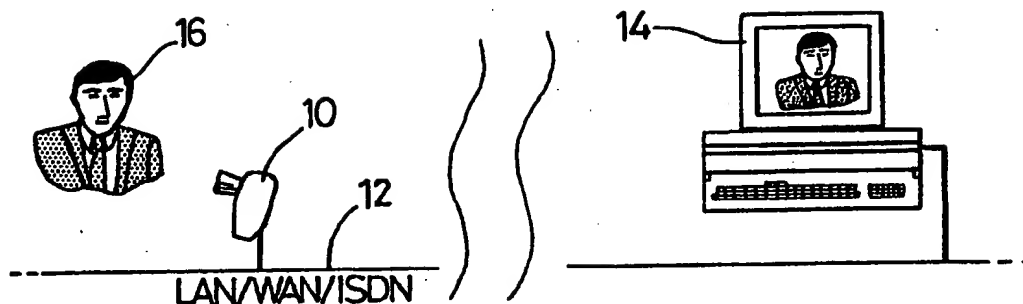


Fig. 1 THE CAMERA INTERFACES DIRECTLY TO LAN/WAN AND THEREBY CAN OPERATE UNDER CONTROL OF ONE OR MORE ATTACHED PCs / WORKSTATIONS.

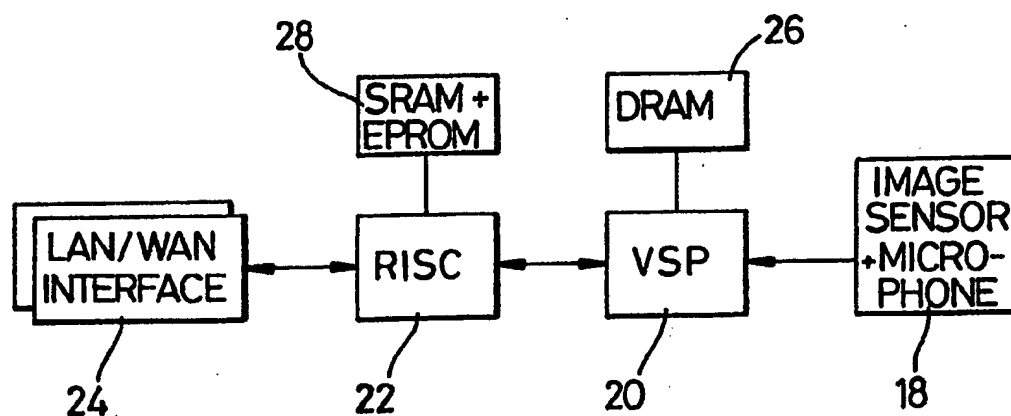


Fig. 2 HARDWARE ARCHITECTURE OF INVENTION ALLOWING CAMERA UNIT TO ATTACH DIRECTLY TO DIGITAL NETWORKS.

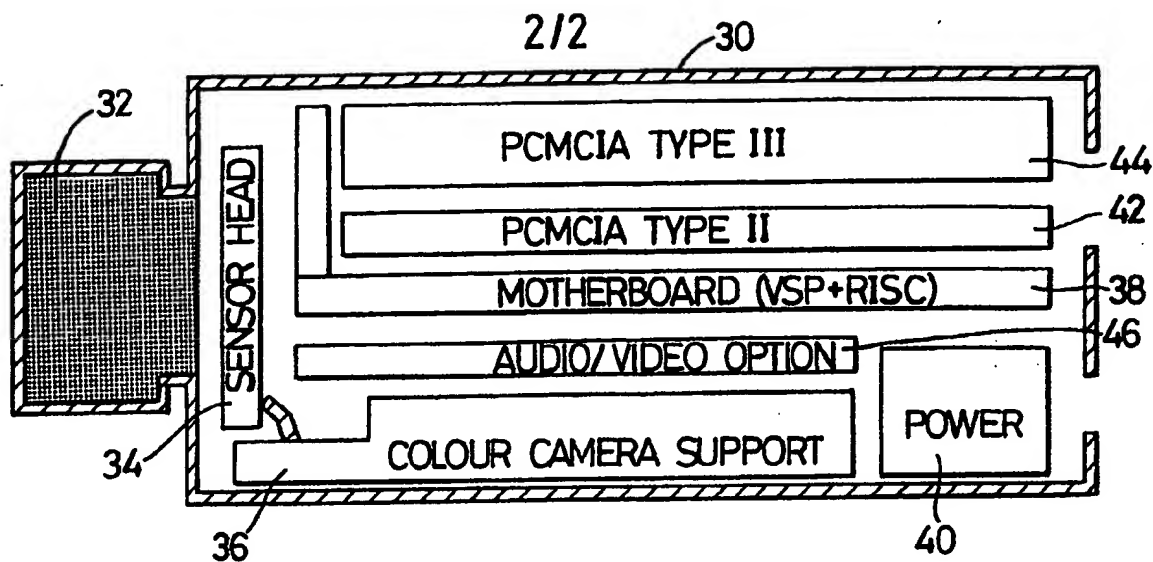


Fig. 3 PHYSICAL CONFIGURATION.

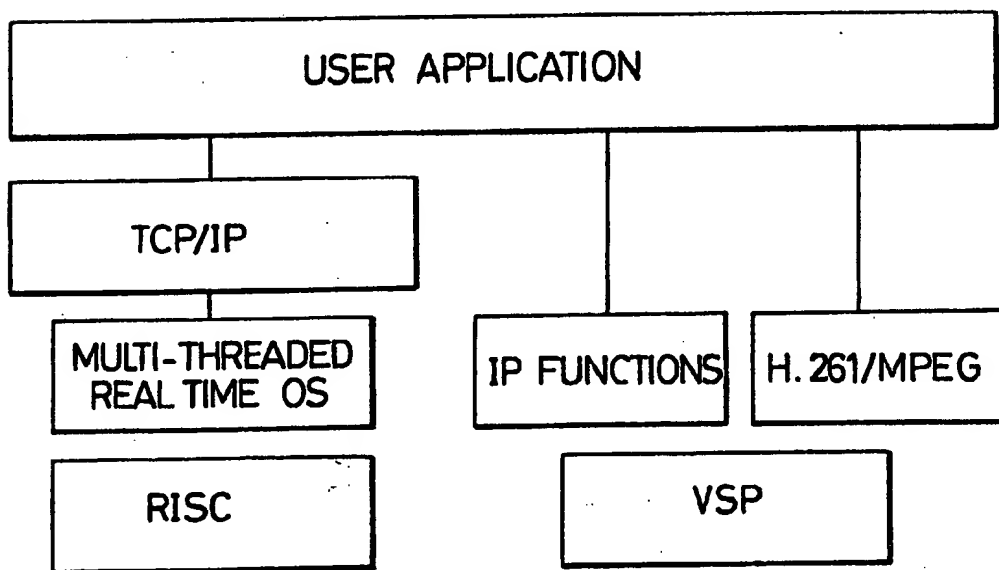


Fig. 4 SOFTWARE ARCHITECTURE OF CAMERA,
ALLOWING IMAGE ANALYSIS IN CONJUNCTION
WITH IMAGE COMPRESSION AND TRANSMISSION
OVER DIGITAL NETWORK.

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H04N5/232

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 H04N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	PROCEEDINGS OF THE SPIE, vol. 1989, 24 - 24 July 1993 BELLINGHAM, USA, pages 88-102, A. MCLEOD ET AL. 'Applications of intelligent cameras'	1-3,5-8
Y	see page 89, paragraph 1.3 'Integrated systems'; see page 91, paragraph 3.1 'Modular architecture' to page 94, paragraph 3.9 ' Other modules'; see figure 1 --- -/--	4,9,10

☒ Further documents are listed in the continuation of box C.

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30 October 1995

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		Int ional Application No /GB 95/01626
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	PROCEEDINGS OF THE SPIE, vol. 2173, 9 - 10 February 1994 BELLINGHAM, USA, pages 178-188, MCCARTHY ET AL. 'High-Performance Image Processing System' see page 186, paragraph 3.2.2. ' Computer Image Processing'; see figure 2 ----	9
X	WO,A,91 07850 (ZONE TECHNOLOGY) 30 May 1991 see page 2, line 14 - page 3, line 22 see page 4, line 5 - page 6, line 1 see page 7, line 1 - line 29 ----	1-3,5-8, 11
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